MARYLAND

# THE BUSINESS OF SPACE SCIENCE

## Governor Martin O'Malley

Space missions launched from Maryland have revolutionized our knowledge of the universe and unlocked mysteries about our planet. Marylanders working in our space industry are exploring and combating global climate change; developing and applying new technologies to space, medicine and other fields; and strengthening the defense of our nation.

With our world-class workforce, federal facilities and public and private institutions of science and discovery, Maryland is well positioned to lead the nation in the space-related economy and to leverage our assets for further growth and discovery.

***Maryland: The Business of Space Science*** outlines how we propose harnessing our assets to increase the economic and innovation potential of this critical industry. Working side by side with our Congressional Delegation and our Senior Senator Barbara Mikulski - we will pursue program policies centered on science R&D, commercialization, manufacturing, satellite servicing, space launch services and workforce readiness.

I invite you to join me in our next mission: To unlock the enormous economic and educational potential Maryland's space science industry offers. Our blueprint for this journey is outlined here and begins with the creation of a **Space Development Authority** within the Department of Business & Economic Development.

## Senator Barbara A. Mikulski

Fifty years after President Kennedy called for our country to send a man to the moon, America is no longer in a space race – we're in a race for our economic future. To win that race we must again work together to out-innovate, out-educate and out-build. That's why I fight so hard to invest in Maryland's federal assets like NASA Goddard, NOAA and NIST.

Local space technology efforts are a major economic development engine in Maryland. Amazing feats have been accomplished by the academic, corporate and government communities that drive space related science, technology and engineering initiatives.

I will continue to work with Governor O'Malley in support of Maryland Space Tech, so we can keep leveraging our federal investment to create jobs in space science, space flight and satellite servicing.

## Introduction

*Maryland: The Business of Space Science* is the second competitiveness research project initiated by the Maryland Department of Business & Economic Development. Modeled on the award-winning *CyberMaryland: Epicenter for Information Security & Innovation, Maryland: The Business of Space Science* inventories the state's space and satellite sector, identifies key assets and opportunities, and sets forth a policy to guide strategic planning and investments.

Maryland has an impressive array of space industry assets. NASA Goddard Space Flight Facility, which manages NASA's observation, astronomy and space physics missions, has called Maryland home for more than 50 years. The Hubble Telescope, the first major optical telescope placed in space, was built, serviced and rebuilt in Maryland. Space Telescope Science Institute in Baltimore supports the Hubble Telescope as well as NASA's optical/UV missions and the James Webb Space Telescope.

Supporting NASA's mission are the Johns Hopkins University Applied Physics Laboratory, which built and launched the New Horizons mission to Pluto, and other flagship labs. Maryland colleges and universities perform cutting-edge aeronautics and space research, with Bowie State University, Morgan State University and the University of Maryland's College Park, Eastern Shore and Baltimore County campuses at the forefront. The state's private sector assets include ATK, Hughes Communications, Lockheed Martin, Northrop Grumman, Orbital Sciences, Raytheon and a host of other space industry giants.

The space industry is an important cog in Maryland's economic engine. Each year, NASA contracts $1.4 billion with Maryland companies. NASA's 10,000 employees and thousands of other Marylanders work in space enterprises related to NASA, NOAA, the U.S. Geological Survey and national security agencies.

Space industry partners in Maryland are adapting existing space science to explore and address climate change in the nation and the world. NASA Goddard scientists are expanding our understanding of the Earth and its life-sustaining environment, the sun, the solar system and the universe. In collaboration with NASA, NOAA develops systems that enhance our comprehension of the role oceans, coasts and the atmosphere play in the global ecosystem.

Maryland is poised to be the nation's nerve center for "green science" and the scientific beachhead to monitor carbon emissions in any new system of cap-and-trade regulations. Already, the NASA Goddard's high performance computing facility – the NASA Center for Computational Sciences – has evolved to become the NASA Center for Climate Simulation, in recognition of the importance of climate modeling.

Given these unique industry assets and innovations, Maryland is strategically positioned to expand our leadership in the space industry even as the industry changes to meet 21st century challenges.

## Industry Overview

As the world economy continued to emerge from the Great Recession, the space industry experienced steady growth in 2010. Worldwide economic activity attributed to the space industry reached $276.52 billion in 2010, a 7.7% increase from 2009. The industry grew by 48% from 2005 to 2010, according to *The Space Report 2011* published by the Space Foundation.

In 2010, U.S. government spending on space increased by only 0.3% over 2009, to $64.63 billion, with the civilian market comprising approximately one-third ($21.0 billion). The $26.66 billion spent by the Department of Defense, coupled with spending estimates for the National Geospatial-Intelligence Agency, the National Reconnaissance Office and other agencies, bring the non-civilian total to $43.66 billion – more than twice the civilian market.

## Jobs and Wages

According to The Space Report 2011, nearly 260,000 were employed in the space industry in the U.S. in 2009. Salaries averaged $92,553, more than double the average private sector salary of $45,155. Maryland ranks third highest among states with an average space industry salary of $110,614, also more than double the private sector average.

Using the Space Foundation's industry definition and 2009 data from the U.S. Bureau of Labor Statistics, Maryland's space industry employment and wages are estimated to be:

- 15,061 jobs
- $1,626,940,997 wages

### Space sectors in Maryland (as defined by the Space Foundation)

- Search, Detection, Navigation, Guidance, Aeronautical and Nautical System and Instrument Manufacturing
- Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
- Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
- Satellite Telecommunications
- Space Research and Technology

By defining the space industry more broadly to include certain satellite communications and computer services companies, the total increases by several thousand jobs. Two notable examples in Maryland include:

- Hughes Communications, which provides broadband satellite networks and services and employs 1,500 people in Maryland.
- Integral Systems, which designs satellite command and control, data processing, flight simulation, integration and test, and signals analysis systems, and employs 230 people at two locations in Maryland.

### Maryland Employment in Space Industry Occupations

| Occupation | Employment | Mean Annual Salary |
|---|---|---|
| Aerospace Engineering and Operations Technicians | 250 | 60,980 |
| Aerospace Engineers | 2,690 | 115,310 |
| Astronomers | 270 | 128,520 |
| Atmospheric and Space Scientists | 400 | 109,530 |
| Avionics Technicians | 340 | 54,070 |
| Chemical Engineers | 660 | 98,750 |
| Materials Engineers | 560 | 108,840 |
| Materials Scientists | 210 | 92,670 |
| Mechanical Engineers | 5,090 | 89,410 |
| Postsecondary Atmospheric, Earth, Marine and Space Sciences Teachers | 70 | 100,780 |
| **Total** | **10,290** | **$100,103** |

*Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics, May 2009*

## Maryland's Space Industry

Maryland's space industry is primarily based on science and research and, to a lesser degree, the defense, security and intelligence markets. The restructuring of the Constellation program has had lesser of an impact on Maryland versus other states, as the state's space sector is less focused on large-scale launch efforts.

### Primary space-related agencies

Among the federal agencies with a presence in Maryland are several with a direct interest in space, including:

- National Aeronautic and Space Administration (NASA) Goddard Space Flight Center
- National Oceanic and Atmospheric Administration (NOAA)
- National Security Agency (NSA) – Fort George G. Meade

Also notable is the NASA Wallops Flight Facility on Virginia's Eastern Shore of Virginia, just outside the Maryland border.

# 2011-2016 SPACE TIMELINE

## 2011

03.2011 NASA/APL's MESSENGER probe *(launch pictured at right)* reaches the orbit of Mercury.

12.2011 Test launch of Orbital Sciences "Taurus II" rocket at Wallops Flight Facility.

## 2012

Orbital Sciences "Taurus II" launches first of 8 missions to resupply the International Space Station (ISS).

Hughes Communications launches JUPITER™ communications satellite.

NOAA Center for Weather and Climate Prediction moves to new building in Riverdale.

## 2013

Orbital Sciences continues with launches from Wallops to resupply the ISS (pictured above).

## 2014

Orbital Sciences continues with launches from Wallops to resupply the ISS

Groundbreaking for Maryland Science, Exploration and Education Center at Goddard.

## 2015

NASA/APL's New Horizons probe reaches Pluto *(pictured above)* in July.

NASA and NOAA launch GOES-R, the first of a new generation of weather satellites.

NASA launches Solar Probe+ to study the corona of the Sun.

## 2016

NASA launches ICESat II to survey polar ice.

NASA launches the James Webb Space Telescope

Opening of Maryland Science, Exploration and Education Center at NASA Goddard.

*Image Credits: ICESat over Antarctica: NASA/Goddard Space Flight Center Scientific Visualization Studio; Pluto: Alan Stern (Southwest Research Institute), Marc Buie (Lowell Observatory), NASA and ESA; Launch of the MESSENGER spacecraft: NASA; International Space Station: NASA March 17, 2009; Artist's Concept of the James Webb Space Telescope: Courtesy of TRW; Background Image: Deepest View of Space Yields Young Stars in Andromeda Halo, Credit NASA, ESA and T.M. Brown; Newborn stars hidden by thick dust: NASA/JPL-Caltech/P.S . Teixeira (Center for Astrophysics)*

*ICESat cloud data over Antarctica. ICESat's orbit was designed to maximize coverage over the great polar ice sheets, providing data on the critically important third dimension, elevation.*

# MARYLAND'S SPACE FACILITIES, RESEARCH CENTERS AND ACTIVITIES

**NASA Goddard Space Flight Center**
- Sciences and Exploration Directorate – World's largest Earth and space science research organization
- Wallops Flight Facility (VA) – Rocket launch site and research center

**National Oceanic and Atmospheric Administration**
- Silver Spring Campus – National Environmental Satellite, Data & Information Service
- NOAA Satellite Operations Facility
- NOAA Center for Weather and Climate Prediction

**U.S. Naval Research Laboratory Center for Space Technology**

**Space Telescope Science Institute**

**Capitol College**
- Space Operations Institute

**The Johns Hopkins University**
- Applied Physics Laboratory
- Space Studies Initiative

**University of Maryland College Park**
- Constellation Universities Institutes Project
- Earth System Science Interdisciplinary Center
- Joint Global Change Research Institute
- Space Systems Laboratory / Neutral Buoyancy Research Facility

**Morgan State University**
- Center of Microwave, Satellite and RF Engineering

**Universities Space Research Association**

**Joint Research Centers with NASA**
- Bowie State University Satellite Operations and Control Center
- Center for Research and Exploration in Space Science and Technology – UMBC, UMCP and USRA
- Goddard Earth Sciences and Technology Center at UMBC
- Goddard Earth Sciences Technology and Research
- UMBC Joint Center for Astrophysics
- UMBC Joint Center for Earth Systems Technology

# PRIMARY SPACE INDUSTRY BUSINESSES AND ORGANIZATIONS


## Further Information

*Maryland: The Business of Space Science* is available at **www.ChooseMaryland.org**

The full report includes a space industry overview with detailed information on Maryland's workforce and specific sector strengths including space related federal agencies, research centers, academic institutions and other relevant assets.

A project of the Maryland Department of Business & Economic Development

**Martin O'Malley**, Governor | **Anthony G. Brown**, Lt. Governor | **Christian S. Johansson**, Secretary
**Roger Venezia**, Principal Investigator

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401 East Pratt Street • Baltimore, MD 21201
888-ChooseMD (246-6736)
www.ChooseMaryland.org

## ACKNOWLEDGEMENTS

**Companies**
Alliant Techsystems (ATK)
Astrox Corporation
Bigelow Aerospace
Boeing
CSC
Earth Networks
Harris Corporation
Hawk Institute for Space Sciences
Honeywell Technology Solutions
Hughes Communications
Integral Systems
Jackson and Tull
Lockheed Martin
ManTech International
Mid-Atlantic Regional Spaceport
Northrop Grumman Electronic Systems
Orbital Sciences
Raytheon
SAFT America
Stinger Ghaffarian Technologies (SGT)
United Launch Alliance
ZGI

**Federal Agencies**
National Aeronautics and Space Administration (NASA)
National Oceanic and Atmospheric Administration (NOAA)

**Higher Education**
Capitol College
The Johns Hopkins University Applied Physics Laboratory
The Johns Hopkins University – Astronomy & Physics Department
University of Maryland, College Park
University of Maryland, Baltimore County
University of Maryland Eastern Shore

**Non-Profit / Associations**
Eastern Shore Defense Alliance
Greater Salisbury Committee
Maryland Business Space Roundtable
Mid-Atlantic Institute for Science & Technology
Space Telescope Science Institute
The Space Foundation
Universities Space Research Association

**State of Maryland Affiliates**
Federal Facilities Advisory Board
Governor's Workforce Investment Board
Maryland Technology Development Corporation

# MARYLAND
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**Summary** *Maryland: The Business of Space Science* seeks to increase the economic and innovation potential of Maryland's space industry by advocating and implementing a series of policy recommendations and strategies in **Science Research & Development, Commercialization, Manufacturing, Satellite Servicing, Space Launch Services,** and **Workforce & Education.** Our recommendations require the participation and engagement of various state and federal agencies, our Congressional delegation, the Maryland General Assembly, and entities such as the Federal Facilities Advisory Board, economic development organizations, educational institutions and the business community. In order to fully realize the opportunities of the space and science sector, the O'Malley-Brown Administration will:

I. Create a **Space Development Authority** to coordinate space industry policies and initiatives.

II. Establish a **Space-Related Business Incubator** with the Maryland Technology Development Corporation (TEDCO).

III. Partner with Congressional delegation to advocate for a proposed **National Center of Climate & Environmental Information** based in Maryland.

IV. Engage the Greater Salisbury Committee to develop a **long-term program plan** for the Lower Eastern Shore to position the NASA Wallops Flight Facility as the premier spaceport for light- and medium-lift launches. Consider funding for the Mid-Atlantic Regional Spaceport (MARS) following the plan's adoption.

## Policy Recommendations

### 1. Exploit and Enhance Maryland's Leadership in Space and Earth Science Research & Development

The research and development that occurs in Maryland is the basic building block for any economic activity that follows and provides the raw materials for emerging disciplines like climate change policy. Our unique strengths in other fields can potentially benefit from the application of space science and earth science to contribute innovative solutions to global problems.

Maryland already has unrivaled expertise in space science and earth science. The State is poised to be the leader in climate change and the emerging climate information and services market by virtue of its expertise in earth sciences and location of key research centers and unique assets for the space industry, most notably NASA Goddard Space Flight Center, National Oceanic and Atmospheric Administration (NOAA), Space Telescope Science Institute and The Johns Hopkins University Applied Physics Laboratory (APL).

#### Recommendations | Space Science

- Market Maryland as the Space Science State for study, discovery and technology transfer. Highlight Maryland's leadership in astronomy, astrophysics, heliophysics and planetary science at space conferences and in industry publications.
- Leverage Maryland's Congressional delegation and the Federal Facilities Advisory Board to advocate for space science and earth science missions to be retained by NASA in the face of budget cuts, overseen by NASA Goddard Space Flight Center and managed in Maryland.
- Develop space and earth science business cluster proposals to respond to funding opportunities from the U.S. Economic Development Administration and other agencies.

#### Recommendations | Earth Science

- Promote Maryland as the ideal location for climate information and research, building on an extensive network of operations, measurement, research and analysis across multiple agencies and research centers. Develop and brand the area around Goddard as a Climate Corridor for businesses engaged in climate research and the development of private sector products and services using climate data.
- Compete for the proposed national center of climate and environmental information to be located in Maryland. Work with local leaders and experts in climate change at the University System of Maryland and The Johns Hopkins University (JHU) to build a compelling case for the creation of such a center and support its competitive location in Maryland. Investigate models in related fields such as the National Weather Center at the University of Oklahoma.
- Building on the Memorandum of Understanding between Maryland and NASA Goddard, work with NASA, NOAA, the University System of Maryland, JHU and others to establish a Global Center of Excellence for climate research and product development to address environmental challenges using space-based resources (satellites, sensors and ground truth). Focus on the impact of climate change on the Chesapeake Bay as a model.
- Identify new capabilities for applying space and earth science knowledge which can benefit mankind and expand industries in agriculture, biotechnology, public health and other fields. Maryland has unique resources including the JHU Bloomberg School of Public Health, the National Institutes of Health, the USDA Beltsville Agricultural Research Center and the Food & Drug Administration.

### 2. Pursue Business Development Opportunities in Space and Earth Sciences and Technology Commercialization to Create New Products, Wealth and Employment

Federal assets are valuable in and of themselves, but the real opportunity lies in creating broader applications for the science they pursue and in generating new business.

#### Recommendations | Small Business & Commercialization

- Partner with NASA Goddard and TEDCO to establish a space-related business incubator adjacent to Goddard's campus or the University of Maryland College Park.
- Work with researchers and entrepreneurs from Maryland's federal facilities and educational institutions to advance the commercialization of space industry technologies, products and services to foster innovation and startup companies.

- Support SMALL Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) funding from NASA and other space related agencies to Maryland small businesses.
- Work with the Congressional delegation to explore a federally-chartered technology development authority to commercialize more NASA and other federally-owned technologies from federal laboratories.
- Identify opportunities for new space-related businesses and support their growth with seed funding, angel investors and venture capital. Utilize InvestMaryland to provide seed funding for emerging businesses engaged in the development of products and services using climate data.
- Link small businesses to opportunities through the Contract Connections initiative.

### Recommendations | Manufacturing, Robotics & Supply Chain Development

- Attract and extend NASA Goddard's and NOAA's supply chain related to space exploration, satellites, instruments and on-orbit services by increasing high-tech manufacturing in Maryland. Expand local awareness of supply chain requirements, making matches with Maryland companies. Encourage additional investment in production facilities by contractors to NASA and NOAA that are already located here. Maximize the manufacturing capability of existing private-sector production facilities in the state.
- Encourage Goddard to take a leadership role in the development of microsatellites in partnership with local education institutions. Leverage Goddard's capabilities in this area to promote industry growth on the Lower Eastern Shore.
- Secure end-user lease agreements at NASA Goddard as a location for small manufacturers.
- Further develop the emerging robotics expertise at Maryland's academic and partner organizations – including Johns Hopkins and APL – to serve as a model for future space science and satellite servicing endeavors.

### Recommendations | Satellite Servicing

- Build on the experience of servicing the Hubble Space Telescope and take advantage of growing opportunities to service and extend the life of existing and aging satellites.
- Promote hosted payloads that combine small loads and instruments in unified missions as a business opportunity for Maryland companies and universities.

## 3. Building on Wallops – An Opportunity for the Eastern Shore

The emerging commercial space market presents a real opportunity for the Wallops Flight Facility and MARS. As one of the few U.S. spaceports licensed for commercial launch, MARS can compete for a share of the increasing market for commercial launches, representing a growth industry for the Lower Eastern Shore. Other complementary activities at Wallops include the Research Range, FAA-certified runways, an experimental unmanned aerial vehicle (UAV) runway and a NOAA satellite receiving station.

### Recommendations | Space Launch Services

- Develop the emerging Lower Eastern Shore cluster of space and defense businesses, emphasizing commercial launches from MARS, as well as the research range, mobile systems, UAVs and other aeronautical and space technologies.
- Aggressively market the assets and advantages of MARS to commercial space companies (for example, SpaceX and Bigelow Aerospace), capitalizing on planned launches to the International Space Station. Determine the necessary improvements to attract future launch capabilities at MARS. Double the annual number of launches from MARS by 2018.
- Lead regional economic development efforts on the Lower Eastern Shore to support Wallops. Engage the Greater Salisbury Committee and other local stakeholders in developing a long-term program plan to position Wallops as the premier spaceport for light- and medium-lift launches.
- Identify potential suppliers to the launch industry at MARS and work to attract the supply chain to the Lower Eastern Shore.
- Support local and regional efforts to invest in incubators, business parks or other facilities as the market for space-related contractor businesses develops.
- Encourage more linkages between Wallops and Maryland's military facilities such as the Naval Research Laboratory and the Naval Air Station Patuxent River and academic institutions including the University of Maryland Eastern Shore.

## 4. Educate and Train People for Space and Earth Sciences Sectors

Consistent with STEM initiatives throughout Maryland's technology sectors, build onto these existing efforts to prepare students for careers in space and earth sciences.

### Recommendations | Workforce and Education

- Support funding at University System of Maryland institutions, the Historically Black Colleges and Universities and other Maryland-based institutions with an historic expertise in space science and earth science. Attract post-secondary degree scholars for space and satellite study and research.
- Coordinate state workforce development investments in STEM education with private sector initiatives of industry employers with the Governor's Workforce Investment Board and the Maryland Space Business Roundtable.
- Develop a statewide middle and high school program to attract students to scientific fields related to the space industry. Partner with Maryland's public schools system – the nation's best – to develop a magnet high school focused on the space industry.
- Expand Maryland's leadership role in space education through the Goddard Space Flight Center, the Space Telescope Science Institute's renowned Hubble Space Telescope education program, JHU's Maryland Space Grant Consortium, and not-for-profit entities such as the Association for Research in Astronomy and the Universities Space Research Association.
- Support the development of the proposed Maryland Science, Exploration and Education Center.